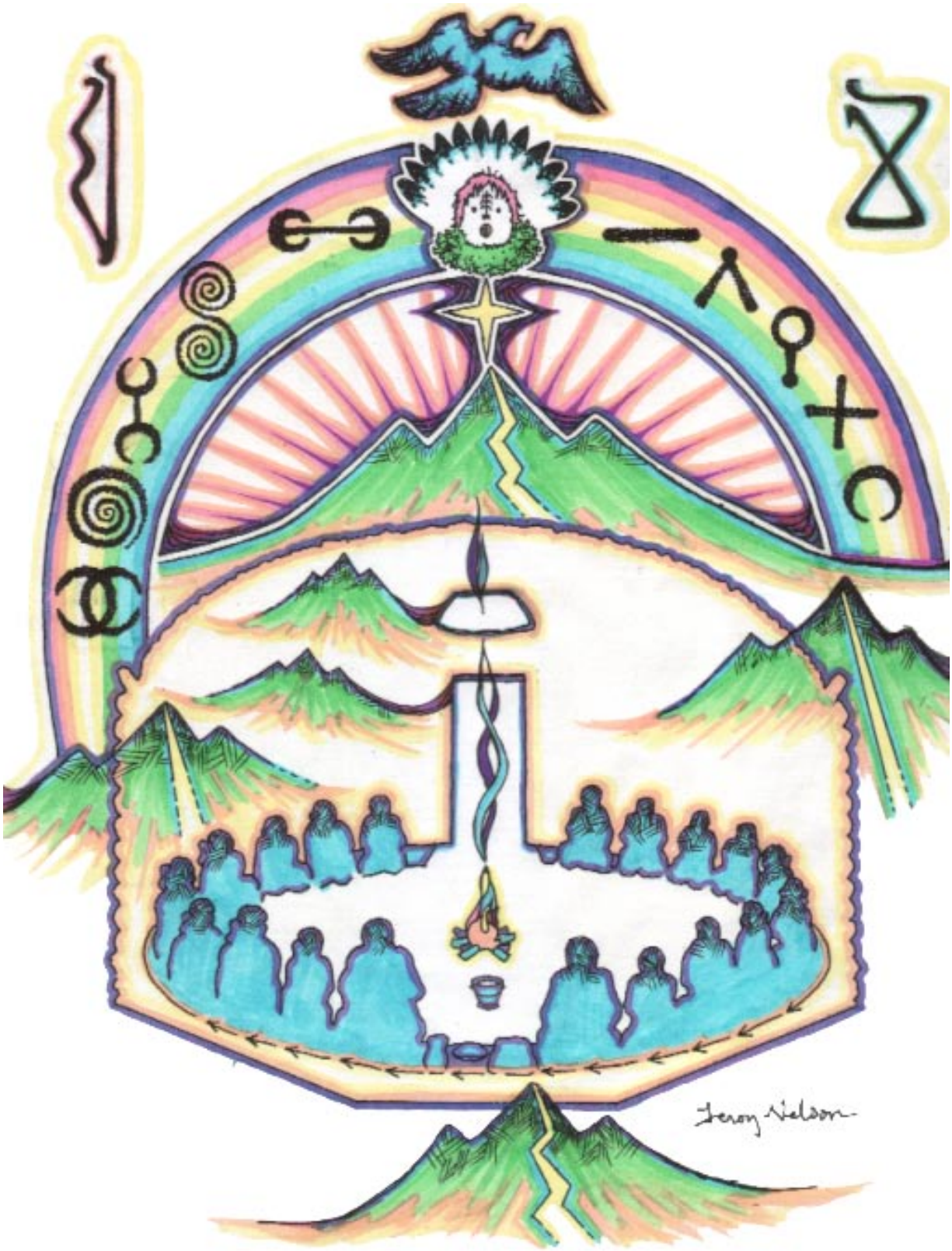
Story Time



Overview

Objective – Explain scientific concepts of stellar evolution and observational astronomy; convey lessons about the Navajo star patterns *Nahookos Bik'a'ii, Nahookos Bi'aadii*, and *Nahookos Bikq* from the Navajo Story; weave the two together through story telling.

Age Range – This activity is designed for ALL ages.

Materials Needed – Background information (provided); images of CassA and M81 (provided); star chart (provided); flashlight; tape; homemade planetarium (see "Stories in the Sky" activity and DVD for instructions on how to assemble it).

Set Up – Follow the instructions and make the planetarium, setting it up in a quiet space and near to an electrical outlet to plug in the fan. Mimicking a traditional Hogan, place the planetarium so the entrance faces East. On the planetarium dome/ceiling, poke the Male and Female Revolver (Big Dipper and Cassiopeia) and Central Fire (North Star) star patterns into the plastic. Use the provided star chart to determine their relative positions. Space them out so they cover a large part of the dome. Tape the provided images of CassA and M81 onto the plastic, using the star chart to find their exact location relative to the star patterns, and taking care not to cover up any holes of the star patterns.

Optional Set Up - Create a central "fire" around which to gather inside the planetarium.

Materials:

- Battery-operated flashlight (extra batteries if necessary)
- 18" squares (approximate size) of colored clear cellophane (red, yellow and/or orange)
- #10 can (coffee, vegetable, fruit or other can)
- Small sticks or 5-10 sheets of brown construction paper

Start with a clean, large-sized vegetable or fruit can (#10 can), with the label removed. Stand or tape the flashlight upright on the bottom of the can, pointing upwards. Next, push the colored cellophane from the middle of the sheet to the bottom of the can around the flashlight (this should help stabilize it) so that the cellophane gives the appearance of flames coming out of the can. Use the small sticks to arrange around the can to give the appearance of a campfire. If you are using the brown construction paper instead of sticks, roll them up into small logs and fasten with tape. Turn on the flashlight right before you begin the activity.

Estimated Time – 30 – 45 minutes; approximately one class period if used in a classroom.

Facilitator or Teacher Pre-Work – Read through the background information. The facilitator for this activity should be chosen for his or her gift in storytelling. It is useful have two facilitators for the activity – one with expertise in the science concepts and the other with expertise in the Navajo story and lessons. The planetarium is suggested for this activity because it is a quiet, special space in which to interact with the "night sky" on the planetarium dome. If you are using the planetarium for the "Stories in the Sky" activity, coordinate with the facilitator of that activity to schedule accordingly, and keep the dome of the planetarium free for this activity.

How To

Guidelines for Facilitating the Activity – This activity is quite flexible. The storyteller's job is to weave the scientific information and Navajo story together. The galaxy M81 and the CassA Supernova Remnant were chosen for this activity because of their "proximity" to the Navajo star patterns Male and Female Revolver. This means that from the perspective of Earth, these celestial phenomena appear to be near or within these star patterns, although they are invisible to the naked eye and require telescopes to see.

There are several links between the scientific concepts and the Navajo story and lessons. One connection centers on *Nahookos Bikq* (The North Star) which represents the central fire of the Hogan, and can symbolize the scientific theory about the nature of a star and what occurs within the core of a star. The scientific background information below describes the concept that the elements required for life as we know it are made within the cores of stars. The suggested story telling outline below offers one way to weave these lines of thought together. As the stories weave, the storyteller can choose how much interaction with the audience he or she likes.

Suggested story-telling outline:

Begin by telling the story of Male and Female Revolver in as much detail as desired (incorporating how they were placed in the sky, how the Male and Female Revolvers influence planting and harvesting, certain ceremonies, and appropriate roles for families). Use the flashlight to indicate the counter-clockwise motion of the star patterns around the North Star. When the story describes the Central Fire (the North Star), indicating its properties and values, the storyteller can begin to ask the group questions about what goes on inside the star. A transition can be made at that point to describing the process of nuclear fusion within a star by which the elements necessary for life as we know it are made (see the scientific background below).

From there, the story can go on to describe how these elements, created in the core of a star, are recycled into space via supernova events (please note only high mass stars become supernovae – refer to the scientific background). Convey that supernovas have been observed by NASA telescopes. Ask everyone to pretend they're looking through a telescope, and shine the flashlight on the image of CassA taped to the dome. Use the observation of CassA as a way to tell about the star cycle of star birth, maturity, death, and recycling of elements for the next generation of stars, planets, and possibly life.

Community Night Event – Field Test in Cameron, AZ

Go on from there to ask for people's thoughts about the possibility of life elsewhere in the Universe. Have them pretend again that they're looking through a telescope, and shine the light on the image of M81 taped to the dome. Tell that the building blocks of life – organic molecules very similar to those found on Earth and even in our own bodies – have been observed through NASA's telescopes. Explain that the pink color in the image represents these building blocks of life in a far away galaxy. Ask whether there is a little or a lot of it (there's a lot!). Tell them that these building blocks are found all throughout space, which means that the building blocks of life are in abundance in the Universe. Ask what they think that means in terms of the possibility of life elsewhere.

Background

SCIENTIFIC BACKGROUND

Star Formation: Throughout the universe, stars form, mature (often with planetary systems), and then die. In so doing, the star can recycle the materials created within it back into space. Stars form in regions of space called nebulae, where the raw material and conditions necessary for formation are present. The concept of star formation begins with diffuse material in clouds of **gases** such as carbon monoxide, hydrogen, and helium, **dust** meaning small rocky particles such as silicates (like beach sand), minerals such as olivine, and organic (carbon-containing) particles like charcoal dust, and **ices** such as water ice. The particulate matter and gases have a random motion. A pressure blast, or "wind" such as the radiation produced from a nearby dying star (supernova) can cause the diffuse material to begin to coalesce and increase in density at certain points which will eventually become discreet stars. A small, growing star is surrounded by a circumstellar disk of spinning dust and gas – like a music CD or a Frisbee, with the young star in the center. Through a process called accretion, the material will condense further. The more mass it gains and the larger it gets, the more material will be attracted to it. In this way, it gains even more mass and gets even larger. Please refer to the film for a visual explanation of this.

Nuclear Fusion Within a Star / Stellar Maturity: As a star continues to form, temperature and pressure slowly increase until the center of the star reaches 15 million degrees Celsius, and the nuclei of the individual atoms begin to fuse. The intense pressure causes hydrogen atoms to fuse into heavier helium atoms. This process gives off tremendous amounts of energy which we observe as light and heat. As stars grow older, they exhaust their supply of hydrogen. The energy released from fusion is no longer enough to counteract the inward force of gravity, and the star's core collapses, increasing pressure and temperature there, eventually up to 100 million degrees Celsius. This new pressure causes helium atoms to then fuse into heavier elements like carbon, nitrogen, and oxygen which are elements essential to life as we know it. Large stars with higher pressures can keep the fusion going and create even heavier elements like calcium, aluminum, magnesium, sulfur, cobalt, nickel, and iron.

Stellar Death and Recycling of Elements: Depending on size and mass, stars can have different fates. Very small stars will stay much as they were. Sun-like stars will move from the Red Giant phase into planetary nebulae, making a space for new stars to potentially form. Very large stars will explode in supernovae. This powerful, explosive event provides the energy to create even heavier elements such as gold and titanium. The supernova event distributes all the elements the star made during its lifetime back into space, to one day be incorporated into new stars, new planetary systems, and maybe new life.

Cass-A: In 1999, the NASA Chandra X-Ray Observatory, a telescope orbiting Earth and "pointing" away from the Earth, was able to take a picture of a supernova remnant in the constellation Cassiopeia (which is also the Navajo star pattern *Nahookos Ba'aadii*). Chandra does not "see" as human eyes do. Human eyes require visible light to image objects. Chandra measures X-rays, which are similar to rays of visible light, but of a much higher frequency. The provided image of CassA shows the X-rays the star let out at the end of its life in a supernova event 300 years ago.

The Mark of a Dying Star NASA/JPL-Caltech/ESA/J. Hora (Harvard-Smithsonian CfA), C.R. O'Dell (Vanderbilt University)

This part of the life cycle of some stars, the supernova, is linked to the possibility of life elsewhere in the universe and the recycling of materials throughout the cosmos. The elements that are cast out into space during a supernova event – oxygen, carbon, nitrogen, etc. – are elements that are necessary for life as we know it. The only place these elements are made is within the core of a star. If the process of star birth, maturation, death, and recycling were not in place, our Solar System would not be the way it is! Current scientific theory states that our Solar System incorporated the material cast off by a nearby supernova event, and our planet and the life on it was made from that material. We, indeed, are made of star stuff. What will become of the material cast out from the CassA Supernova? Could new stars and solar systems form in its wake?

M81: The image of the galaxy (called M81; 12 million light years away from Earth and visible within the constellation Ursa Major through binoculars or a small telescope) was taken by the NASA Spitzer Space Telescope in 2003. Like Chandra, Spitzer does not "see" like human eyes which rely on visible light. Rather, Spitzer "feels the heat" of objects, and creates an image of them. The original image, provided here as part of this activity, shows a pink color (false color) in the spiral arms of the galaxy. This color represents very interesting material – extremely tiny bits of rocky material such as silicates (similar to beach sand), and organic (meaning carbon-containing) molecules. The organic molecules that Spitzer found are most interesting because they are similar to molecules central to life here on Earth, such as chlorophyll, which is made by plants and enables their growth. The molecules Spitzer found are called Polycyclic Aromatic Hydrocarbons, or PAH's for short. PAH's are flat molecules, shaped like chicken-wire, and can have many different shapes. Many of the molecules of life that are part of our bodies are related to PAH's found in space. Even chocolate and caffeine are simple PAH's!

The Spitzer Space Telescope has directly observed the tell-tale signature of PAH's throughout space, in fact, these molecules seem to be just about everywhere. They are common in our own Milky Way galaxy and in distant galaxies such as M81. PAH's are chemically very stable and don't break apart in the high radiation environment in space. PAH's may become part of newly forming planets around other stars where they could be incorporated into other living things. The discovery of PAH's in other galaxies in such abundance makes scientists wonder about the possibility of life elsewhere.

An Excerpt From:

Só Diyin Dine'é

Told by Irvin K. James, 2001
Transcribed by Sylvia Jackson

Produced by the Office of Diné Culture, Language, and Community Services
Division of Diné Education

The Holy Ones discussed the growing process, as they observed and understood it. If all living things return to the Earth and are replaced with new life, then there is a growing process in place. The Holy Ones met, discussed, planned, and laid out the constellations by which the People will understand the passage of time, growing, and aging.

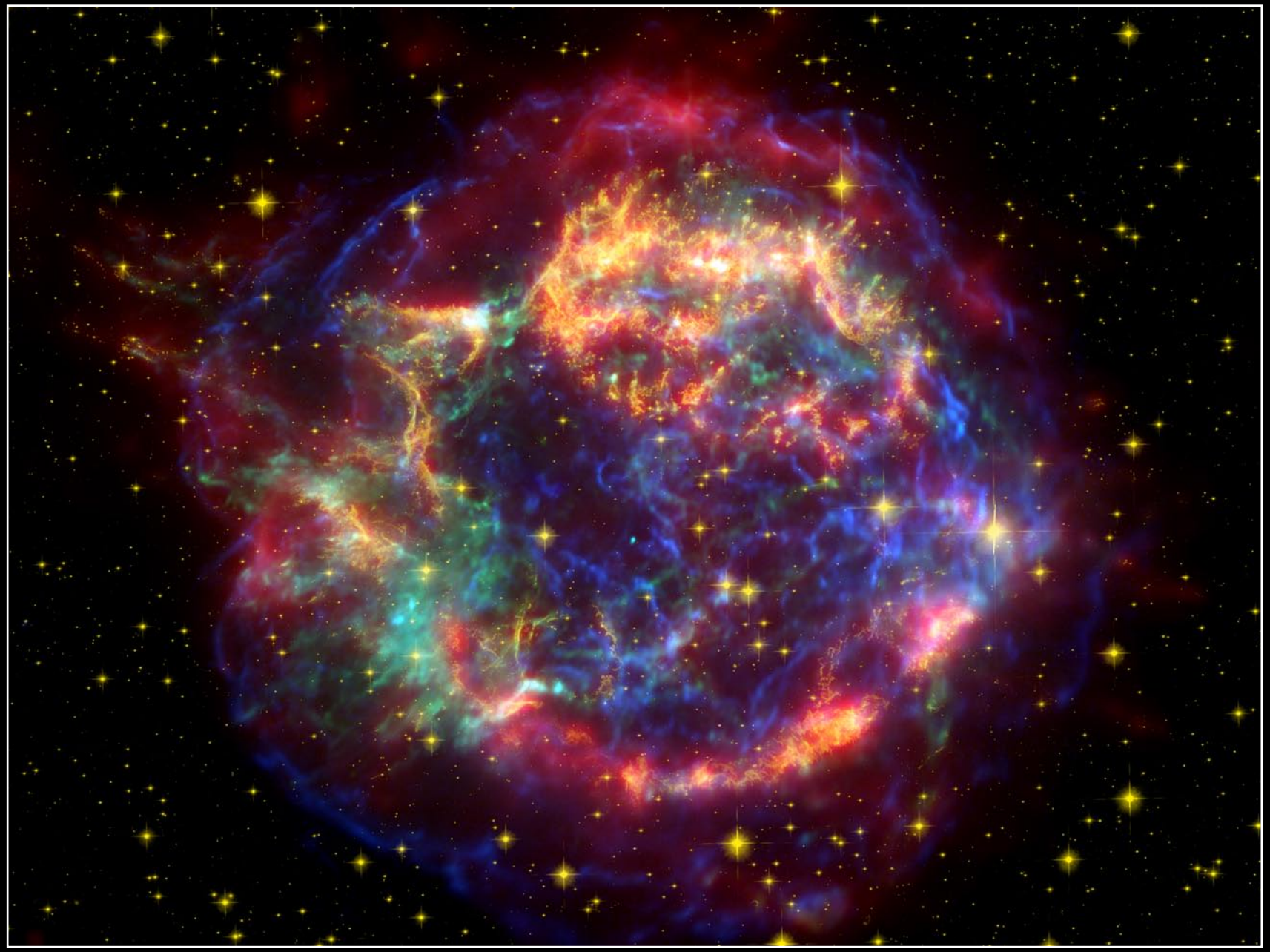
One day was set aside for everyone to participate. Haashch'eeyalti'i placed a flawless buckskin on the ground. Other Holy Ones brought precious gems of all colors, sizes, and shapes to produce specific patterns and designs to depict their character and ability. First man constructed a pattern he called Nahookos Bik'a'ii, the Big Dipper. He chose seven colorful stones in the pattern. First Woman constructed a pattern she called Nahookos Bi'aadii, Cassiopeia, and had five stones in the pattern. They placed the patterns in the northern sky around the North Star, with their own fire hearth between them. The pair will revolve around their fire hearth, Nahookos Bikq, the North Star. Everyone was satisfied with the arrangements.

The constellation patterns placed in the sky were discussed and designed for specific purposes such as the Nahookos Bik'a'ii and the Nahookos Bi'aadii and the fire hearth, Nahookos Bikq. The pattern exhibits changes of the season. In the early spring, Nahookos Bi'aadii will be visible in the northeastern sky. Nahookos Bik'a'ii will be visible in the same location in the early fall evening. Nahookos Bikq, the North Star, remains in one location all the time. All constellations revolve around the North Star.

The traditional understanding is that the constellation patterns depict proper roles and responsibilities of families. Nahookos Bik'a'ii reigns over the fall and winter seasonal activities for the People. Yei'ii Bichei and ilnashjinji hataal are winter healing ceremonies. Nidaa and Hozhonjii Hataal are the spring and summer healing ceremonies under the reign of Nahookos Bi'aadii. Being aware of the purposes of the constellations helps in understanding the traditional practices of Diné Way of Life.

Graphics

The following several pages contain the provided graphics for this activity: the images of CassA and M81 to be cut out and pasted on the dome for the activity, and the star chart to guide placement of the holes in the planetarium dome.



Cassiopeia A Supernova Remnant

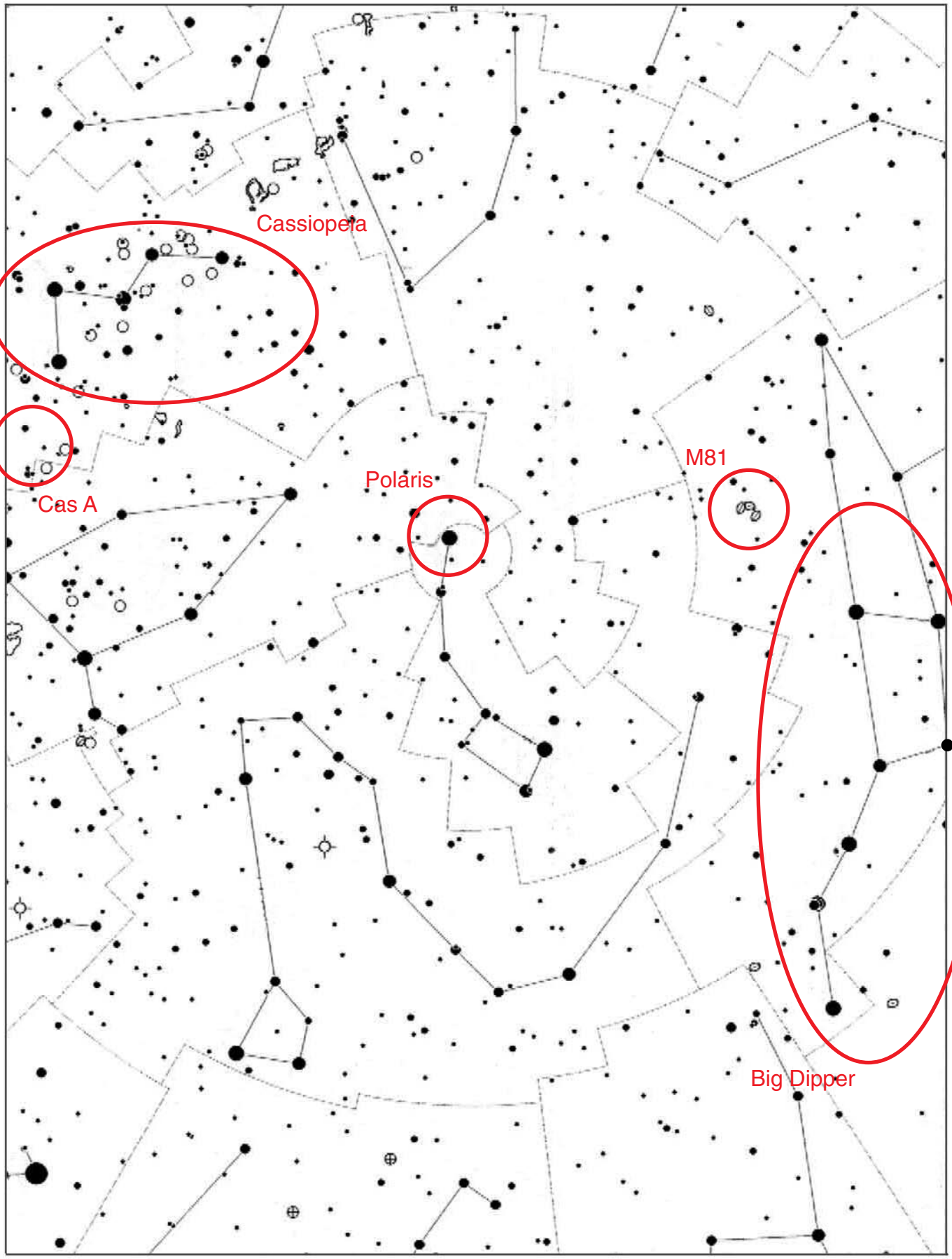
Spitzer Space Telescope • MIPS / HubbleSpace Telescope • ACS / Chandra X-Ray Observatory

NASA/JPL-Caltech / D. Krause (Steward Observatory)

Spiral Galaxy M81

Spitzer Space Telescope • IRAC

NASA / JPL-Caltech / S. Willner (Havard-Smithsonian CfA)


Cassiopeia
Cas A
Polaris
M81
Big Dipper